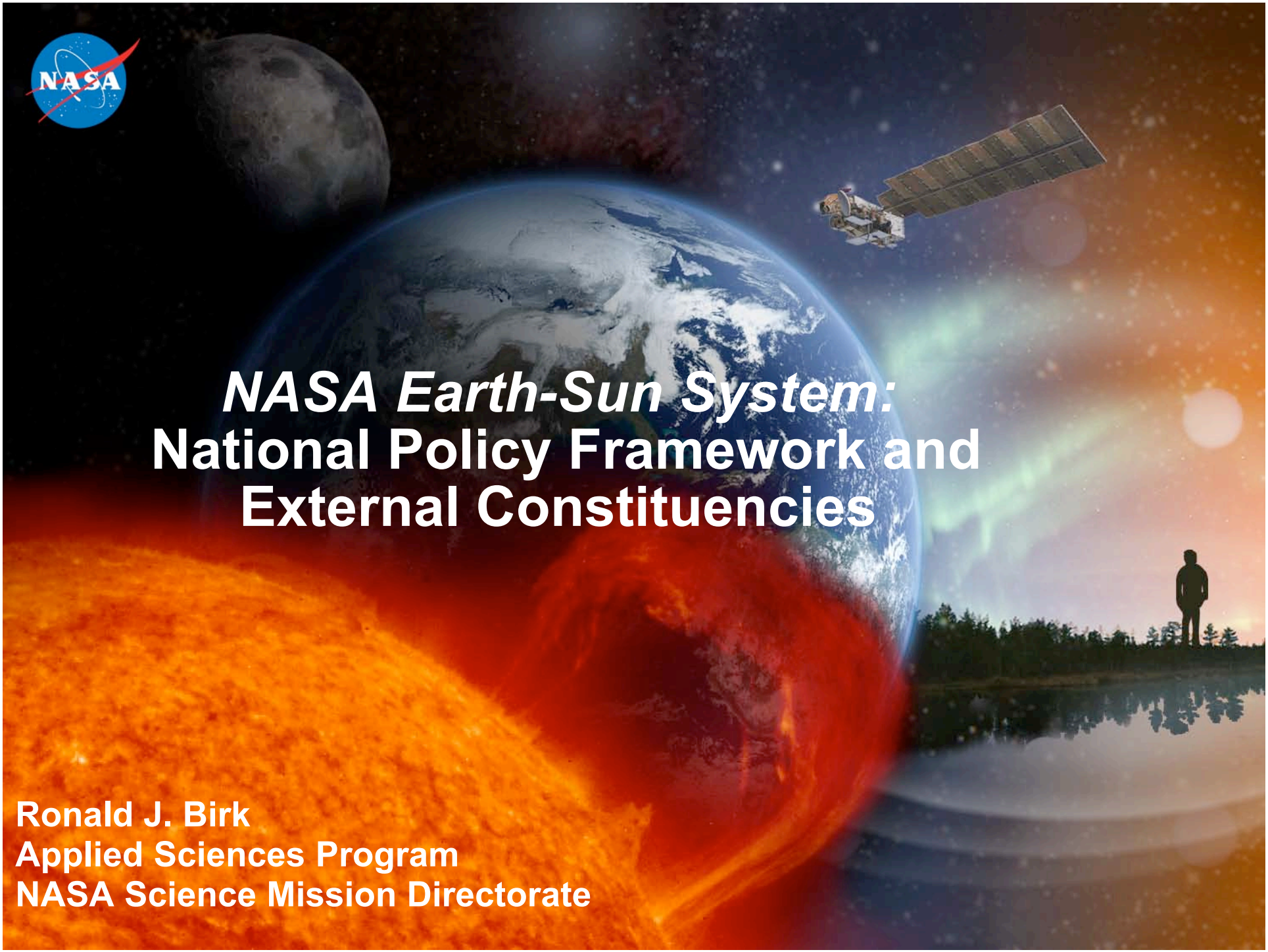


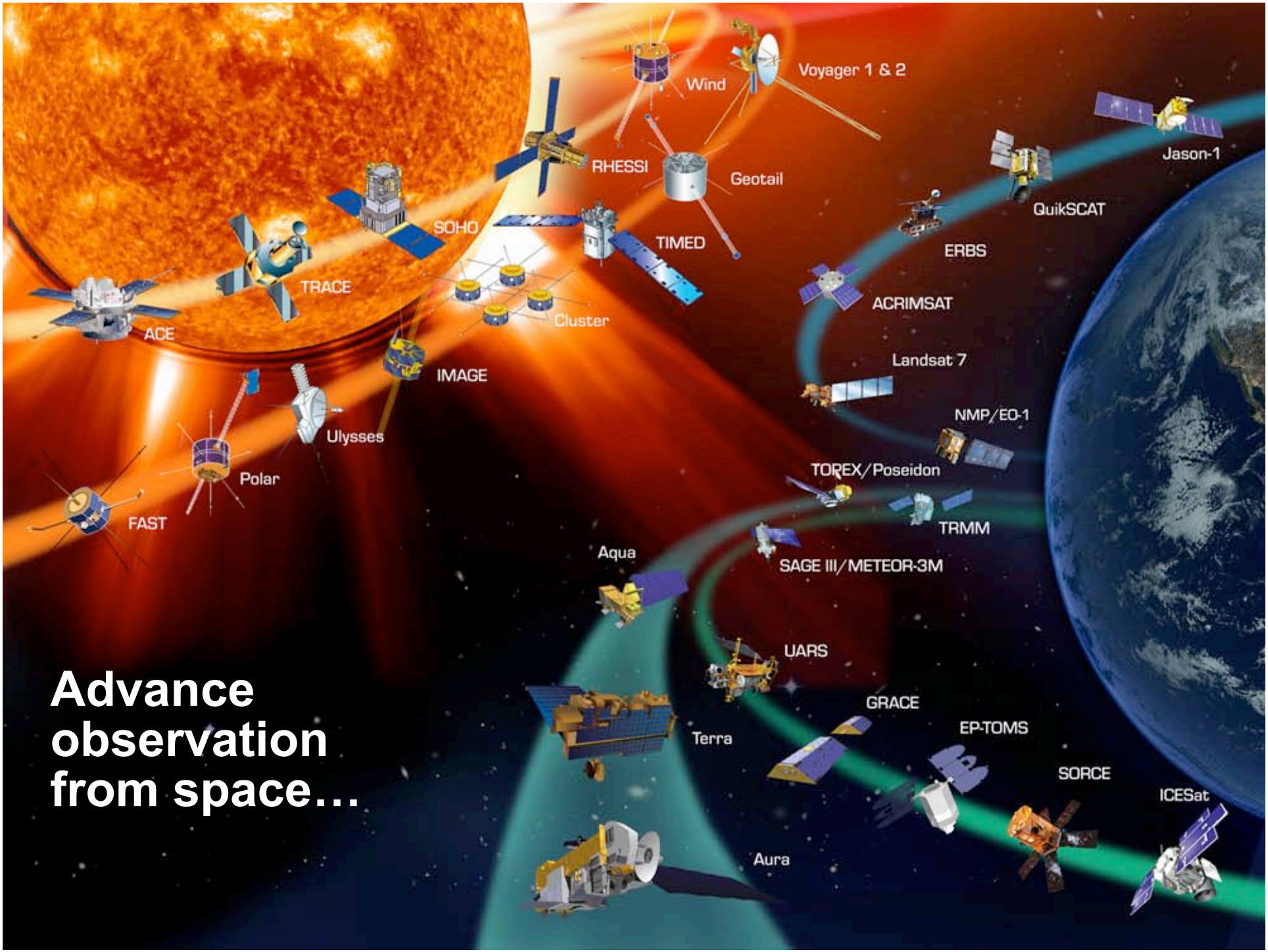
NASA Earth-Sun System: National Policy Framework and External Constituencies

Ronald J. Birk
Applied Sciences Program
NASA Science Mission Directorate

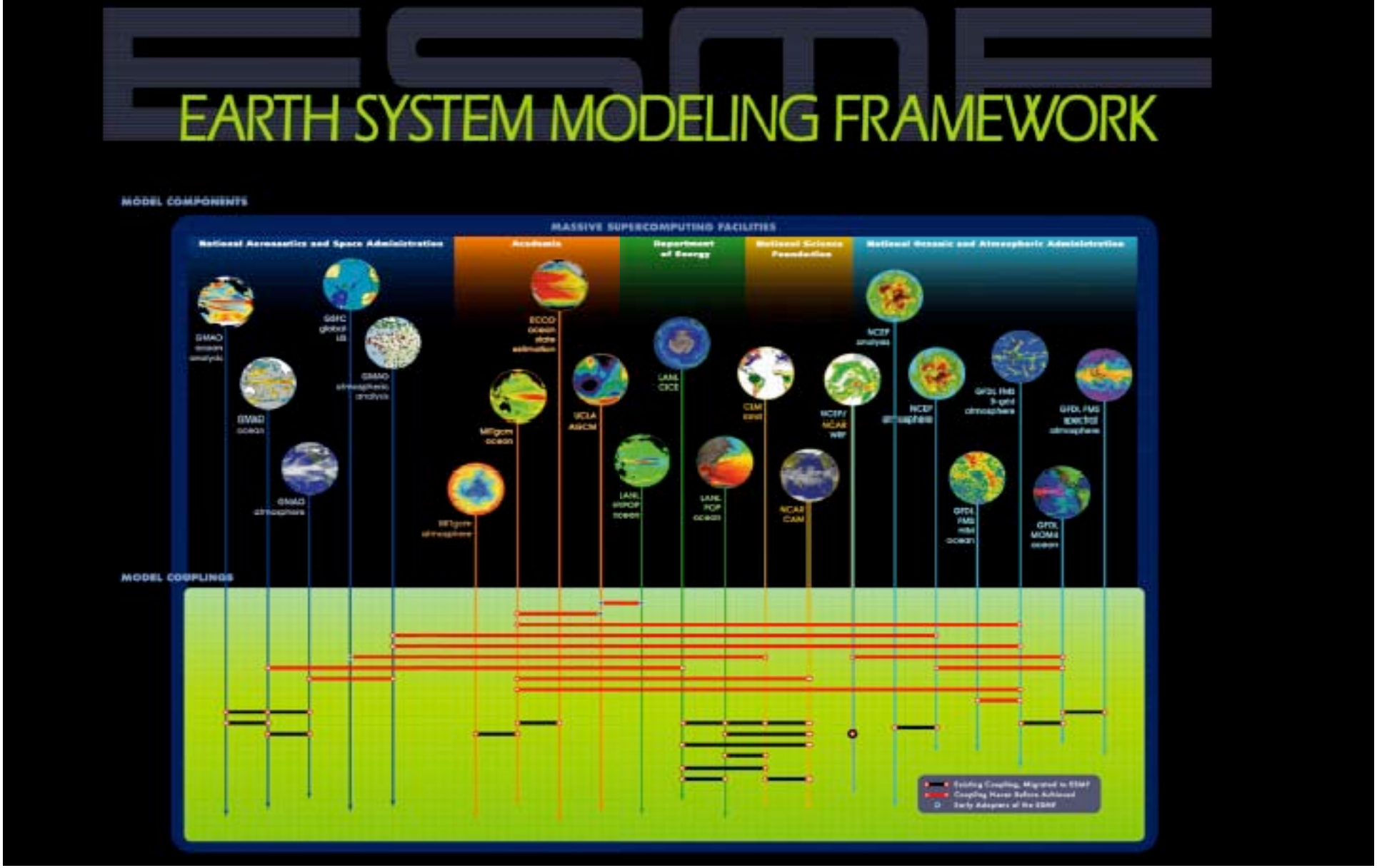
Agency Strategic Roadmap #9

- Title: Earth Science and Applications from Space
  - Short Title: “Earth”

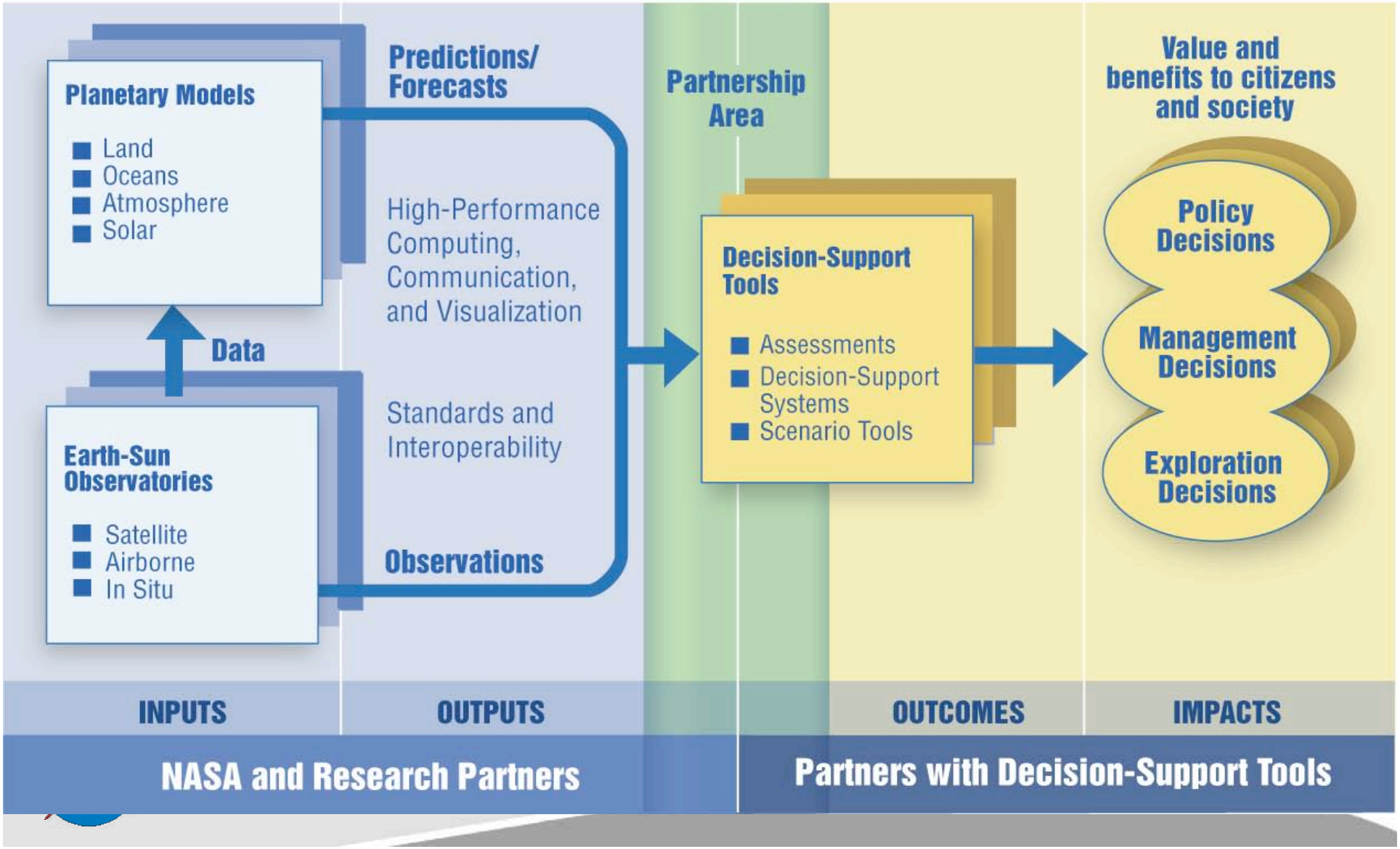
- Objective: Research and technology development to
  - advance Earth observation from space,
  - improve scientific understanding, and
  - demonstrate new technologies with the potential to improve future operational systems


Wind
Voyager 1 & 2
RHESSI
Geotail
Jason-1
QuikSCAT
SOHO
TIMED
ERBS
TRACE
ACRIMSAT
Cluster
ACE
Landsat 7
IMAGE
NMP/EO-1
Ulysses
TOREX/Poseidon
Polar
TRMM
FAST
SAGE III/METEOR-3M
Aqua
UARS
GRACE
Terra
EP-TOMS
SORCE
ICESat
Aura
Advance observation from space…

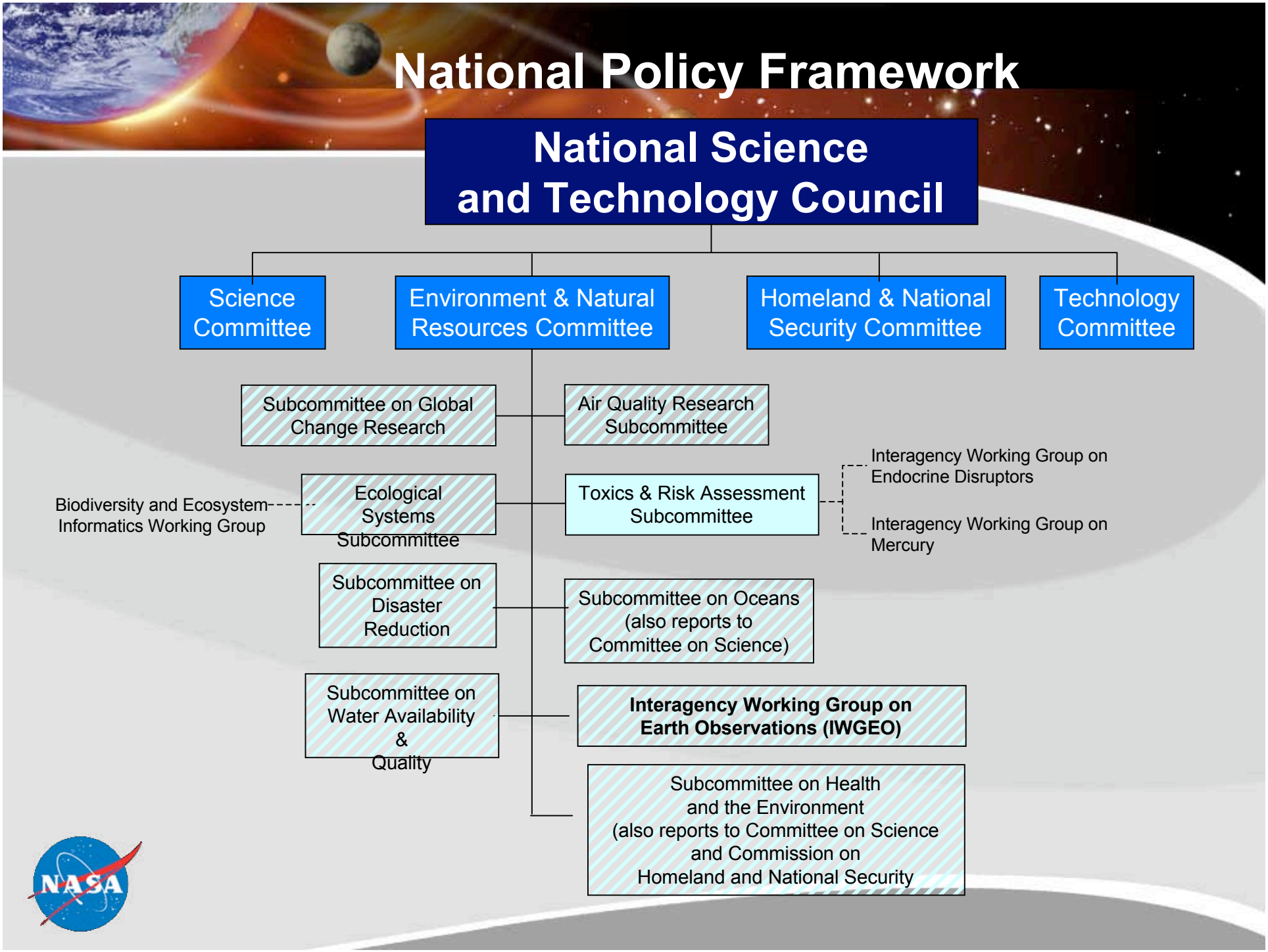
Improve scientific understanding …



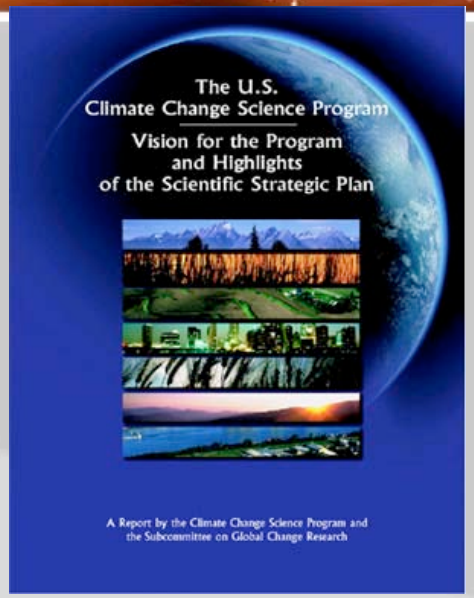
Demonstrate improvements to future operational systems

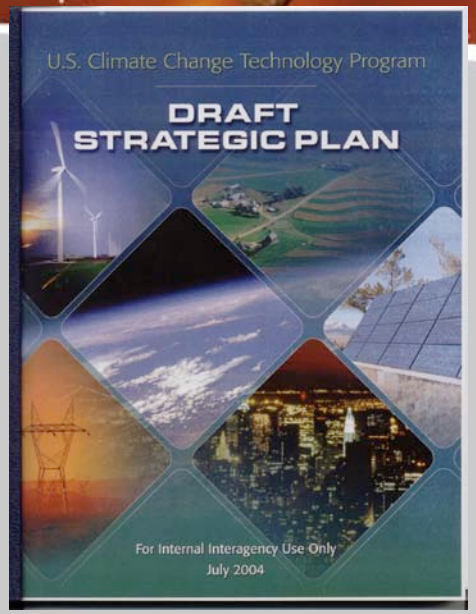


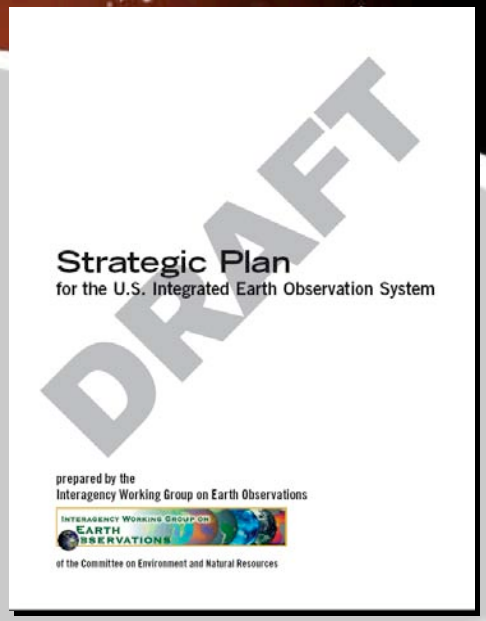
National Policy Framework

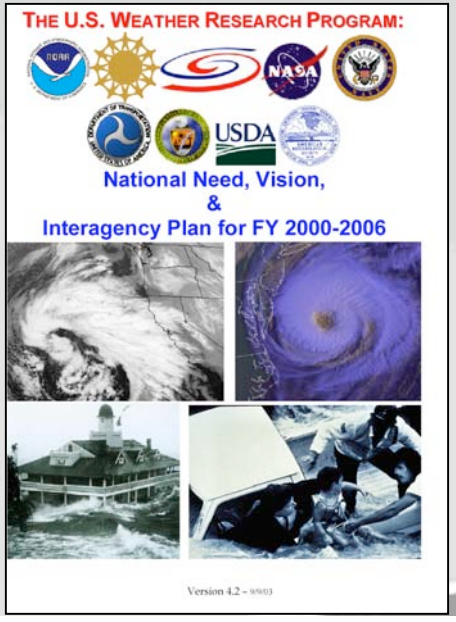


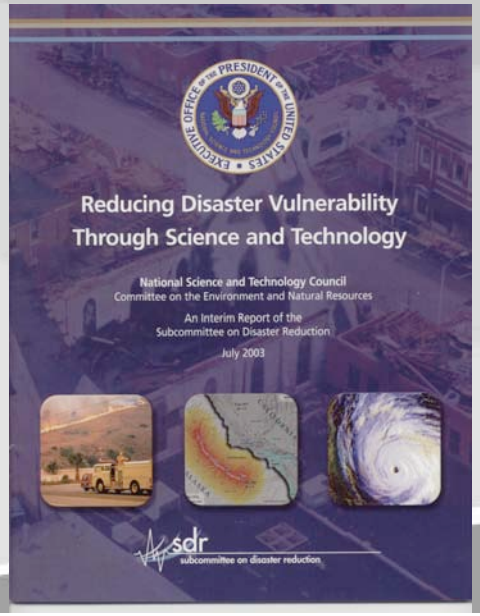
U.S. Plans for integrating Earth Observations











U.S. Commercial Remote Sensing Space Policy: Civil Agency Implementation Plan

December 12, 2003

Implementation Plan Working Group (IPWG)

National and International Programs benefiting from NASA R&D

Priority	National Programs	International Programs
Global Earth Observation	Interagency Working Group on Earth Observations (IWGEO) Integrated Earth Observation System, 17 Agencies	Group on Earth Observations (GEO) 55 countries, 33 international organizations
Climate Change	Climate Change Science Program (CCSP, 13 Agencies) Climate Change Technology Program (CCTP, 12 Agencies)	Intergovernmental Panel on Climate Change (IPCC)
Weather	U.S. Weather Research Program (USWRP, 7 Agencies)	World Meteorological Organization (WMO) & THORPEX
Natural Hazards	Subcommittee on Natural Disaster Reduction (SDR, 14 Agencies)	International Strategy for Disaster Reduction (ISDR)
Sustainability	CENR Subcommittee on Ecosystems	World Summit on Sustainable Development (WSSD)
e-Government & Information Services	Geospatial One-Stop (GOS, 12 Agencies) and the Federal Geographic Data Committee (FGDC, 19 Agencies)	World Summit on the Information Society
Commercial Remote Sensing	U.S. Commercial Remote Sensing Space Policy	

Group on Earth Observations

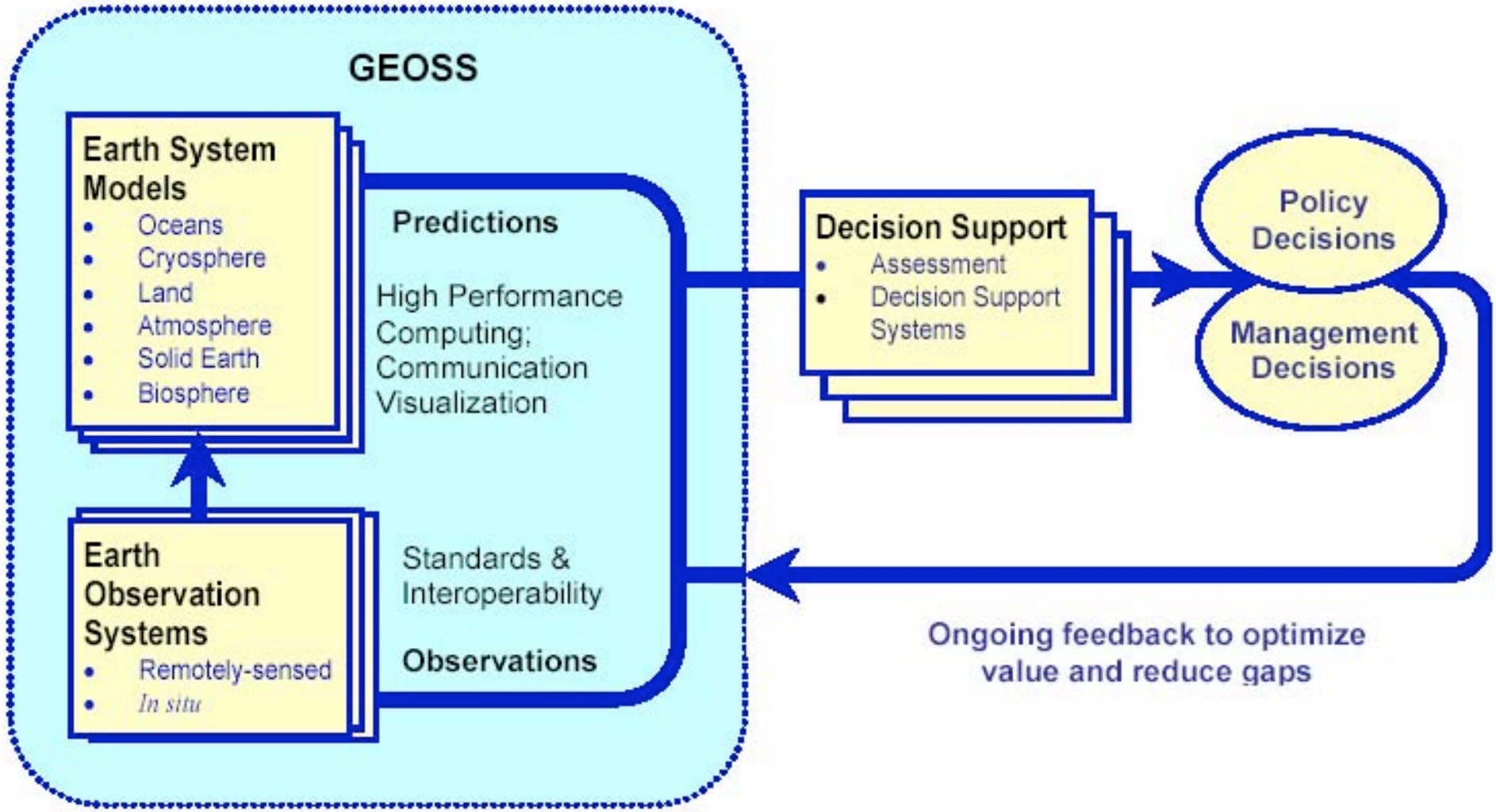
Group on Earth Observations

Earth Observation Summit I

Earth Observation Summit II

Group on Earth Observations

GEOSS Architecture



Group on Earth Observations

Focus on Societal Benefits

Natural & Human Induced Disasters

Water Resources

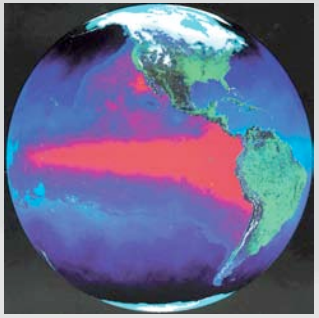
Ecosystems

Human Health & Well-Being

Energy Resources

Sustainable Agriculture

Weather Forecasting



Climate Variability & Change

Oceans

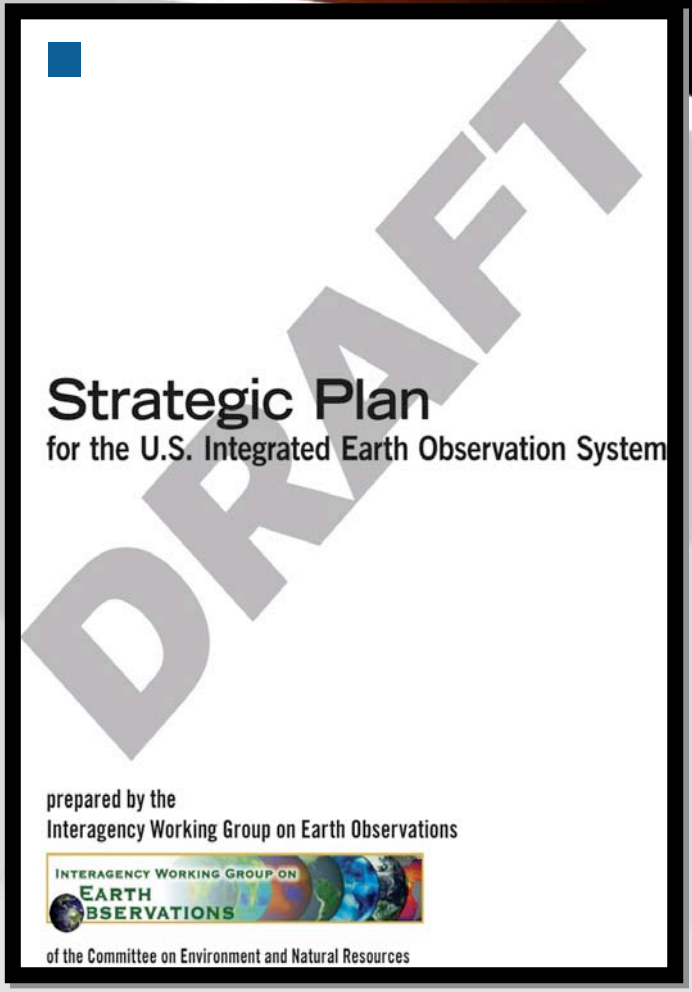
Interagency Working Group on Earth Observations

U.S. Contribution to GEOSS

VISION

- Enable a healthy public, economy, and planet through an integrated, comprehensive, and sustained Earth observation system.

http://iwgeo.ssc.nasa.gov



Interagency Working Group on Earth Observations

IWGEO – U.S. Interagency Effort

Co-chaired by:

- Ghassem Asrar (NASA)
- Cliff Gabriel (OSTP)
- Greg Withee (NOAA)

TABLE KEY

P = primarily provides data

U = primarily uses data

B = uses/provides data

Societal Benefit Areas	U.S. AGENCIES															
	DOC/NIST	DOC/NOAA	DOD	DOE	DHHS/NIEHS	DHS/FEMA	DOI/USGS	DOS	DOT	EPA	NASA	NSF	Tennessee Valley A.	Smithsonian	USAID	USDA
Weather	B	B	U	U	U	U		B	U	B	U	U	U	B	B	
Disasters	P	U	U	U	U	B	U	U	U	P	B	U	U	U	U	
Oceans	B	B	B	U	U	B			U	P	B		U	U		
Climate	B	U	B	U	U	B	U	U	U	B	B		U	B	U	
Agriculture	P		U	U	U	P	U		P	P	B		U	B	P	
Human Health	P		P	B			U		B	P	B		U	B		
Ecology	B		B	U		B	B		B	P	B		B	B	B	
Water	B		B	U	U	B	B	U	B	P	B		U	B	U	
Energy	P		B	U	U	B	P	U	B	P	U	B	U	U		

Interagency Working Group on Earth Observations

Integration: 4 Perspectives

- Policy and Planning Integration
  - Focus on specific societal benefits
- Societal Issue Focused Integration
  - Integrated System Solutions
- Scientific Integration
  - Modeling of Earth processes
- Technical Systems Integration
  - Coordination of observing system technology and data management systems
  - Account for observing system evolution

NASA contribution to IWGEO/GEO

Agricultural Efficiency

Air Quality

Aviation

Carbon Management

Coastal Management

Disaster Management

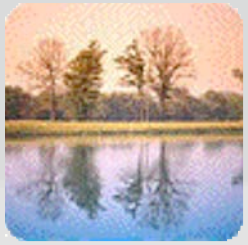
Ecological Forecasting

Energy Management

Homeland Security

Invasive Species

Public Health



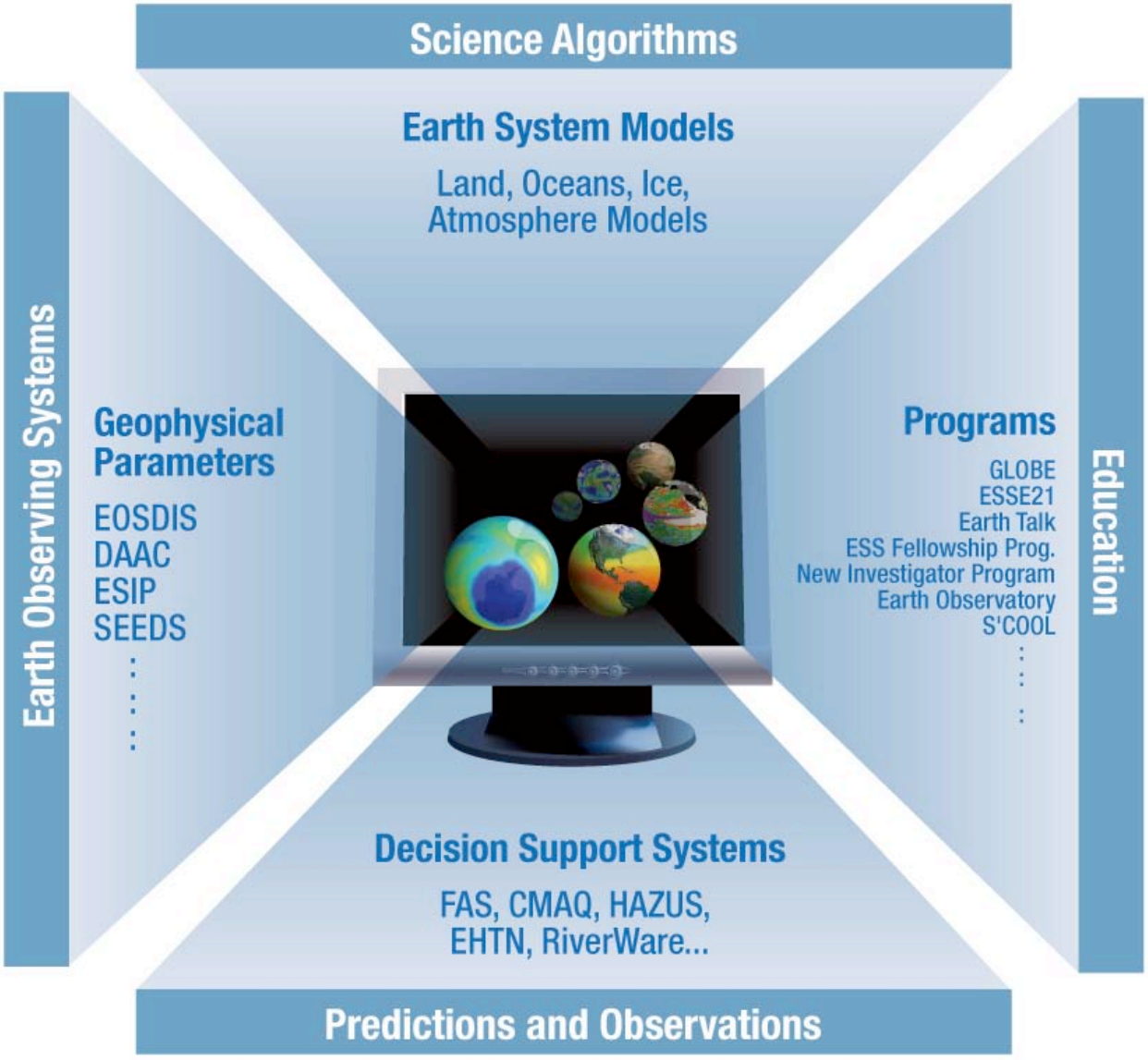
Water Management

National Application	Partner Organizations	Decision-Support Systems
Agricultural Efficiency	USDA,NOAA	CADRE—Crop Assessment Data Retrieval and Evaluation (USDA)
Air Quality	EPA,NOAA,USDA	CMAQ—Community Multiscale Air Quality Modeling System AIRNow AQI—Air Quality Index
Aviation	DOT/FAA,NOAA	NAS-AWRP—National Air Space-Aviation Weather Research Program
Carbon Management	USDA,DOE,NOAA	CQUEST—Support to the Energy Act of 1992,Section 1605b
Coastal Management	NOAA,EPA,NRL	HAB—Harmful Algal Bloom Bulletin/Mapping System CREWS—Coral Reef Early Warning System
Disaster Management	DHS/FEMA,NOAA,USGS,USFS	AWIPS—Advanced Weather Interactive Processing System HAZUS-MH—Hazards U.S.—Multi-Hazards
Ecological Forecasting	USAID,NOAA,NPS,CCAD,USGS	SERVIR—Regional Visualization and Monitoring System
Energy Management	DOE,UNEP,NOAA,NRC	RETScreen—Energy Diversification Research Laboratory (CEDRL) NEMS—National Energy Modeling System
Homeland Security	DHS,USGS,NOAA,NGA,DOD	IOF—Integrated Operations Facility IMAAC—Interagency Modeling and Atmospheric Assessment Center
Invasive Species	USGS,USDA,NOAA	ISFS—Invasive Species Forecasting System
Public Health	NIH,CDC,DOD,EPA	PSS—Plague Surveillance System EPHTN—Environmental Public Health Tracking Network MMS—Malaria Monitoring and Surveillance RSVP—Rapid Syndrome Validation Project
Water Management	EPA,USDA,USGS,BoR	RiverWARE—Bureau of Reclamation decision-support Tool AWARDS—Agricultural Water Resources and decision-support Tool BASINS—Better Assessment Science Integrating Point and Nonpoint Source

Near-Term Opportunities

- Data Management System for Earth Observations
- Improved Observations for Disaster Warnings
- Global Land Observing System
- Sea Level Observing System
- National Integrated Drought Information System
- Air Quality Assessment and Forecast System

Data Management: Earth-Sun System Gateway



Disaster Management

HAZUS-MH - Risk Assessment and Loss Estimation

January 12, 2004,
S. Ambrose

Primary Partners:

State 2- Improved
Hurricane prediction
Flood prediction
Severe Storm prediction
Wildfire prevention and prediction
Earthquake prediction

Socioeconomic Impact

Transfer of advanced event-modeling capabilities using next-generation hardware, software, and communications

Outcomes: Improvement of FEMA capabilities across all hazards and phases

Impacts: Reduce losses across all disasters

Land use/Land cover, changes in earth's surface topography and Improved geodetic imaging, ocean measurements to track hurricanes

Outcomes: Improvement of FEMA planning, and response capabilities to weather and natural hazards

Impacts: Reduce losses across all weather-driven Disasters and earth movement

Improved measurements of soil moisture, global precipitation, water vapor, and wind

Outcomes: Improvement in wildfire prediction, HAZUS-MH High Winds Module Final Version

Impacts: Reduce losses related to hurricane, fire, and high wind disasters.

Understanding of Earth's gravity field And terrestrial reference frame changes in geomagnetic field and understanding of sea level change and climate

Outcomes: Improvement of the HAZUS-MH earthquake assessments And flood inundation for coastal areas

Impacts: Reduce losses related to hurricanes and earthquakes.

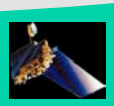
Production of assimilated data sets, reanalysis of long period observations

Outcomes: Improvement in climate data and information for risk assessments

Impacts: Reduce losses related to flood and wind disasters. Better community planning

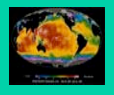
State 1- Earthquake Damage assessment


QuikSCAT

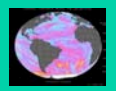

Terra


Aqua


TRMM


OcnTopo


Hydros


* OSWinds


Aquarius


NPOESS

* Pre-formulation

2004 2005 2006 2008 2010 2020

An operational decision support system for quantification and verification of solutions for natural hazard predictions.

Disaster Management

Integrated System Solutions

EARTH SYSTEM MODELS

- **Weather:** *FVGCM,* ***ETA-12, WRF***
- ***Hurricane:*** ***HURSIM, H*Wind, HUREVAC***
- ***Earthquake/Landslide:*** ***MMI, QuakeSim, GPS***
- ***Flood:*** ***SLOSH, FLDWAVE, SBEACH, WAVEWATCH III, STWAVE, HURSURGE***
- **Damage Cost Models:** ***ATC-13***
- **Wildfire:** ***FARSITE, BEHAVE***
- **Terrain:** ***BARC***

****Supported Non-NASA Model***

Data

EARTH OBSERVATORIES

- **Land Surface Topography/Land Use/Cover:** LandSat *SRTM, ASTER, TERRA/AQUA, AVHRR,* ***AURA***
- **Wind/Weather:** *QuickSCAT, GOES,* ***AURA, NPP, NPOESS, GOES-R***
- **Ocean Surface Height/Waves:** Topex-Poseidon
- **Global/Regional Precipitation:** TRMM, AVHRR, GOES, DMSP, **GPM**

****Future Mission***

Predictions

- Hazard Maps
- Earthquake vulnerability and prediction
- Flooding and coastal inundation
- Hurricane/Typhoon Track and Intensity
- Precipitation amount
- Wind Velocity/Direction
- Surface Deformation

- Atmospheric Temperature Water Vapor, Winds
- Severe Weather (Lightning)
- Volcanic Ash
- Aerosols, Smoke
- Cloud Properties
- Global Precipitation
- Land/Terrain/Use/Veg
- Aquifers
- Wetlands

Observations

DECISION SUPPORT TOOLS

NOAA/AWIPS (**A**utomated **W**eather **I**nformation **P**rocessing **S**ystem)

- Weather prediction and observations
- Weather watches and warnings
- Data Dissemination Assimilation, models
- Public Access to information

DHS/FEMA HAZUS-MH – Hazards U. S.

- Disaster Mitigation/ Preparedness
- Built Environment risk & loss
- Socio-economic impacts

USDA/Forest Service: RSAC - Remote Sensing Applications Center

- Wildfire location/intensity
- Post Fire Recovery
- Strategic/Tactical Operations

VALUE & BENEFITS

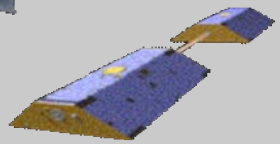
- Identify/Prioritize high-risk communities
- Reduction in lives and property lost
- Reduction in damage cost and time to recovery
- Anticipate the scope of disaster-related damage
- Improve disaster response
- Community Planning
- Land Resource preservation

7/16/2004

Disaster Management System

QuikScat

GRACE



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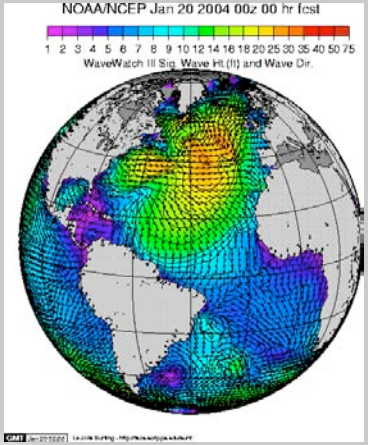
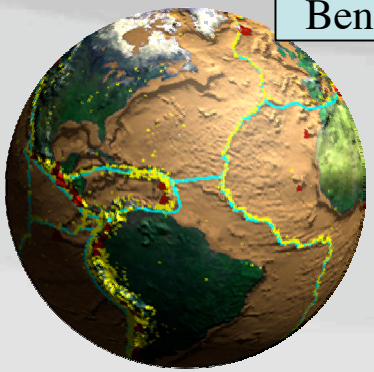


Exploitation

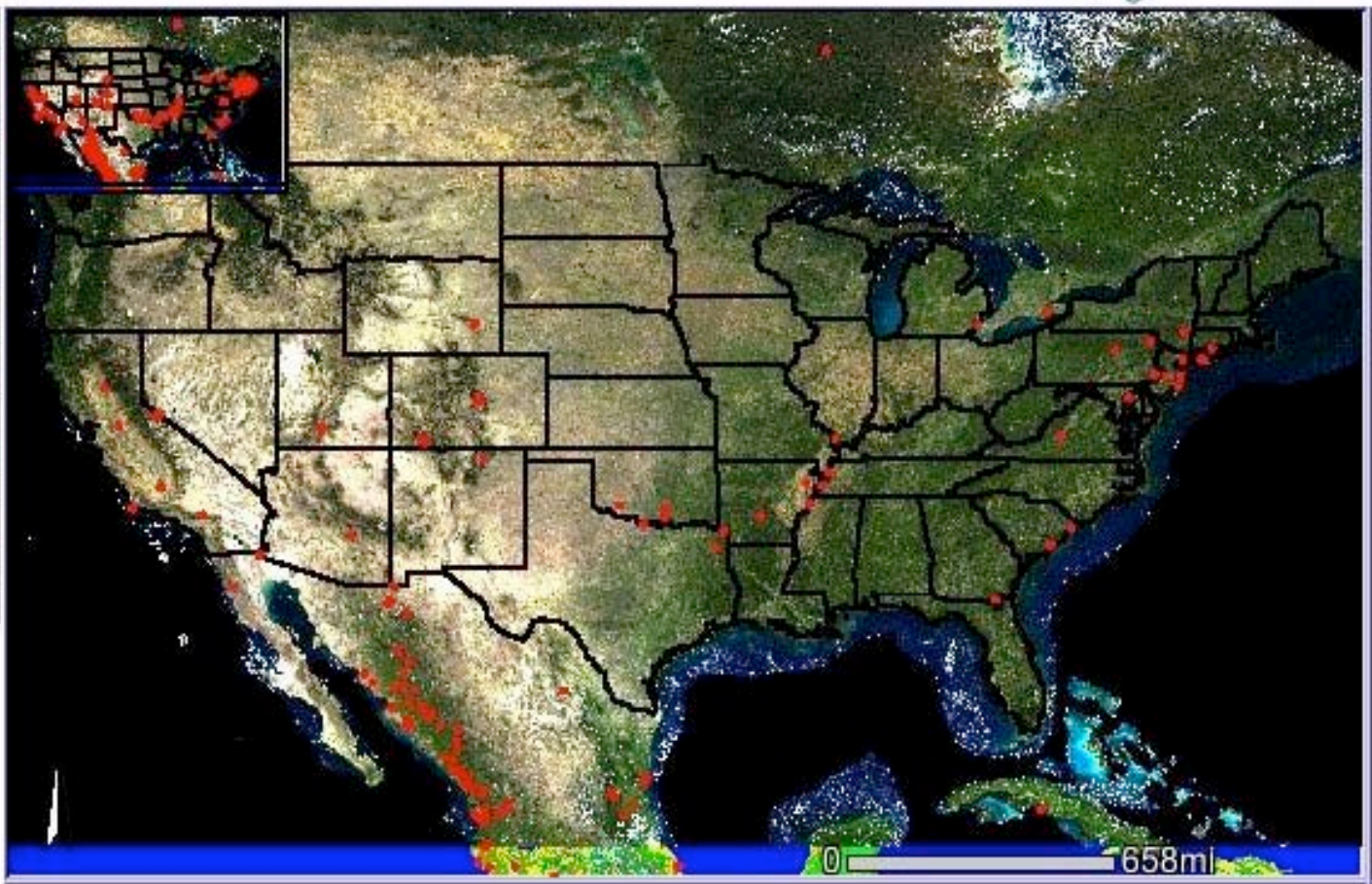


Societal Benefits

EOSDIS & DAACs

USFS/NASA Rapid Response Service

Continental US Web Fire Maps



Layers

Visible Active

- MODIS Active Fire Detections
- Continental US
- MODIS Surface Reflectance 500M
- AVHRR Land Cover (GLCF)

Refresh Map

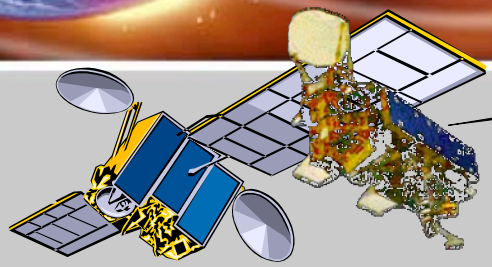
Date Query

Enter the dates in YYYY-MM-DD format.

Start Date 2002-06-17

End Date 2002-06-19

Rapid Response Systems Architecture



Terra & Aqua

Direct Broadcast
Receiving Station

L1B Data

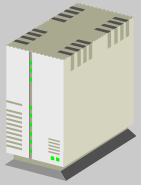
T+30min

USDA Forest Service
Remote Sensing
Application Center

Active Fire Maps
http://activefiremaps.fs.fed.us
Three times per day

Backup Feed
L1B Data

EDOS



Rapid Response System
NASA/GSFC

Active Fire
Locations

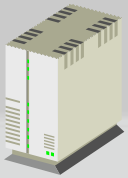
T+5hrs

Burn Severity Maps
Handcrafted Imagery

MODIS
L0 Data

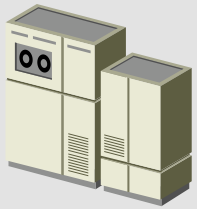
T+2-5hrs

Active Fire Locations
Selected Imagery

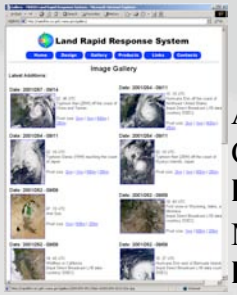


University of Maryland
Geography Dept

Active Fire
Locations
GOFC Fire Partners

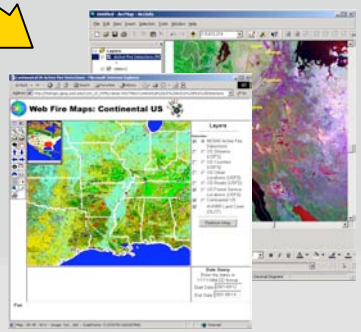


GES DAAC
NASA/GSFC



T+5hrs

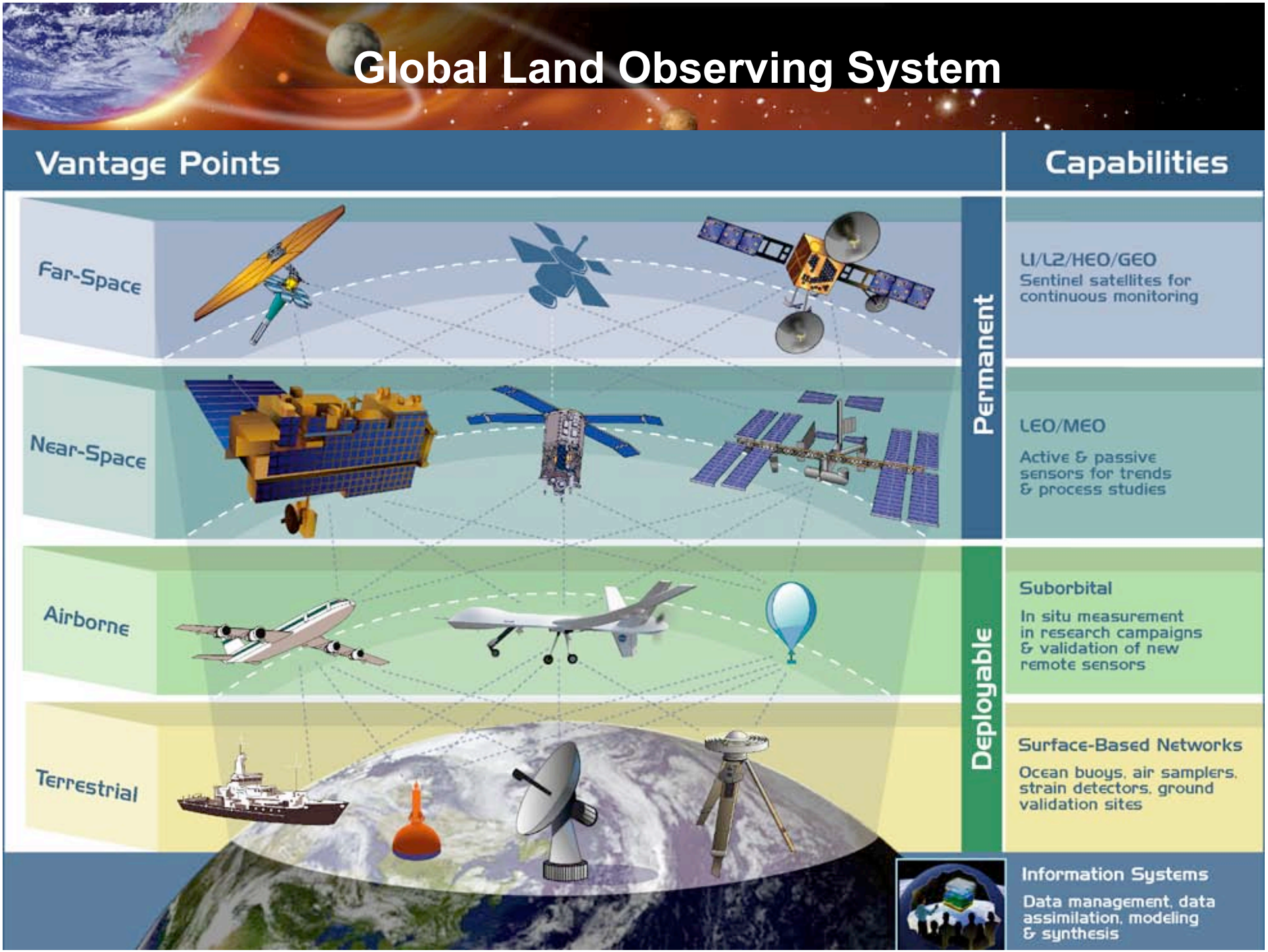
Active Fire and
Corrected Reflectance
http://rapidfire.sci.gsfc.nasa.gov
MODIS home page
http://modis.gsfc.nasa.gov



Web Fire Maps and Fire
Feature Server
http://firemaps.geog.umd.edu

NASA Earth
Observatory
http://earthobservatory.nasa.gov

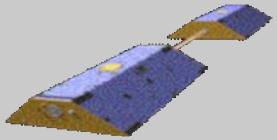
Global Land Observing System



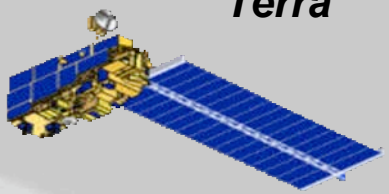
Drought Information System

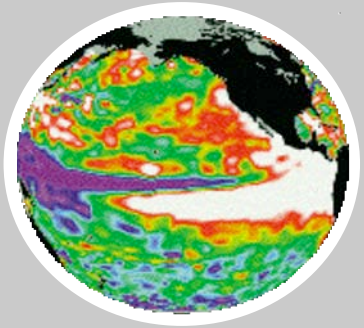
Jason

GRACE



Terra





Downlink

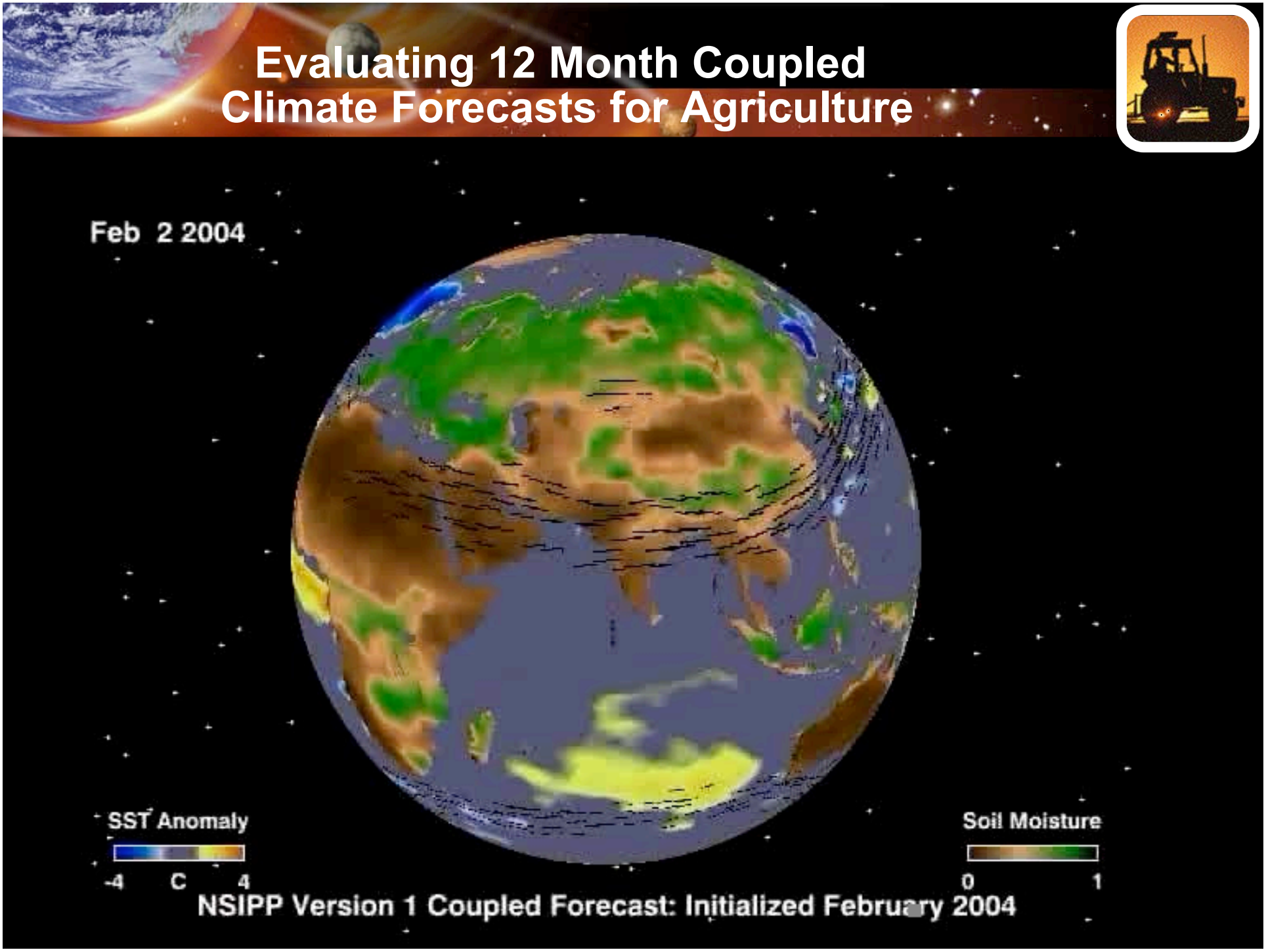
EOSDIS & DAACs

Exploitation

Societal Benefits

CADRE:
USDA Decision Support System for Global Crop Production Assessments

Evaluating 12 Month Coupled Climate Forecasts for Agriculture



Agricultural Efficiency

Global Agricultural Production Assessments

January 22, 2004,
E. Sheffner

Socioeconomic Impact

CADRE: DSS that integrates Landsat & AVHRR with limited crop models and coarse gridded weather data

Rapid Response Delivery system for daily MODIS products. Reservoir stage products.

Outcomes: New source of data available to analysts offering unprecedented spatial, spectral, and temporal coverage

Impacts: More accurate acreage and production assessments. Earlier detection of potential problem areas

New MODIS-based vegetation, ET, and TRMM products for CADRE database and crop models

Outcomes: New source of precipitation and land cover data to analysts offering more comprehensive knowledge base for in-season crop monitoring

Impacts: More accurate and timely drought monitoring. Enhanced prediction of yield

Evaluate, via data simulations, new data sources (OCO, Aquarius, HYDROS) on predictive capabilities and production estimates.

Outcomes: New tools for analysts to exploit enhanced system capability for region-specific modeling and prediction

Impacts: More accurate production estimates

Transition to VIIRS/NPP, and other new data sources as they come on-line. Integrate data into operational systems. Benchmark new capabilities.

Outcomes: New tools to exploit enhanced capability for region-specific modeling and prediction. Ability to compare new data to archive

Impacts: More accurate crop assessments based on new operational capabilities

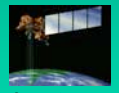
Transition to NPOESS with cross calibration to legacy systems. Integrated system to ingest data from wide variety of commercial high-resolution systems.

Outcomes: Better information on hot spots

Impacts: Long-term operational sustainability that exploits all available systems

Enhanced DSS integrating new generation image products, precip. data, and crop models for more accurate crop production assessments

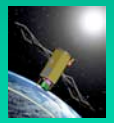
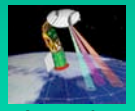
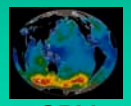
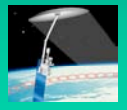

TOPEX

TRMM

Lsat 5,7

Terra

Jason-1

Aqua

NPP

OCO

Aquarius

GPM

HYDROS

NPOESS

Current — 2006 — 2008 — 2010 — 2012

01/09/04

Enhanced operational decision support system for prediction and monitoring of agricultural production.

Agricultural Efficiency

Integrated System Solution

EARTH SYSTEM MODELS

- Agricultural Meteorological Model: *AGRMET*
- 2 Layer Soil Moisture Models:
- Crop Models: *CERES, AGRISTARS, Mass, URCROP, Sinclair*

**Supported Non-NASA Model*

Data

EARTH OBSERVATORIES

- Land: *Aqua*, *Terra, Landsat 7,* SRTM, TOPEX, JASON-1, *NPP, NPOESS, HYDROS*
- Atmosphere: *TRMM, OCO, GPM*
- Ocean: *SeaWIFS, QuikScat, Aqua, Aquarius*

**Future Mission*

Predictions

- 12 Month Global Seasonal Surface Temperature/ Soil Moisture/ Precipitation Forecast
- Crop marurity
- Crop yield
- Water availability

Observations

- Biomass
- Land Cover/ Use
- Land Surface Topography
- Ocean Surface Currents
- Global Precipitation
- Soil Moisture
- Reservoir level
- Evapotranspiration
- Radiation

DECISION SUPPORT TOOLS

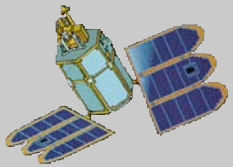
- **PECAD/CADRE** (**C**rop **A**ssessment **D**ata **R**etrieval **&** **E**valuation)
  - Generated time series graphs for rainfall, temperature , and soil moisture
  - Multi-year time series/ crop comparisons
  - Vegetation anomaly detection
  - Automated web products

VALUE & BENEFITS

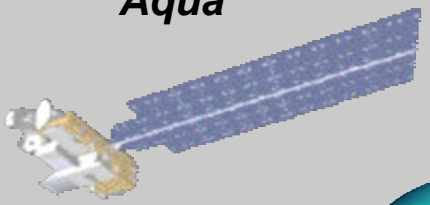
- Early warning of problems in major agricultural commodities
- Better seasonal yield estimates
- Early warning of food shortages
- Greater economic security for agriculture sector

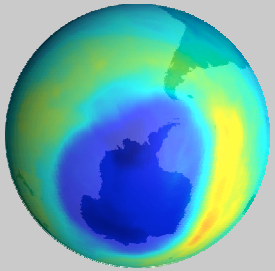
Air Quality Forecast System

TOMS-EP



Aqua

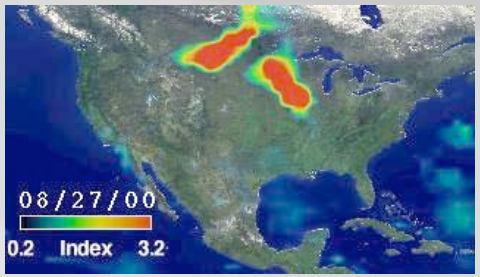




Downlink

Societal Benefits

Exploitation

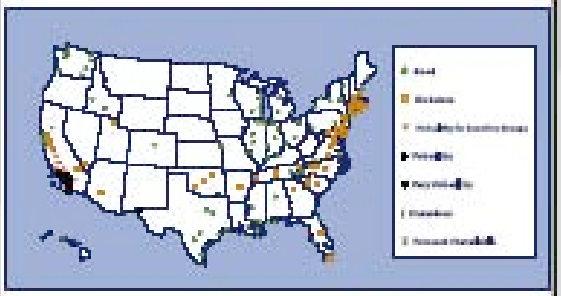


EOSDIS & DAACs

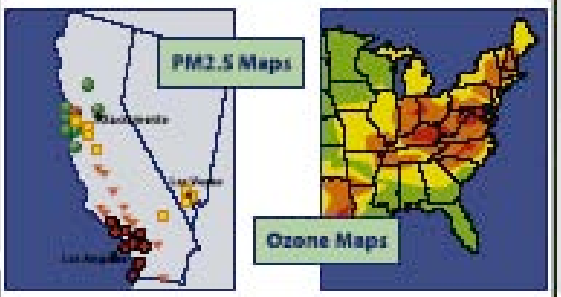
AIRNOW
www.epa.gov

The U.S. EPA has developed the AIRNow website to provide the public with easy access to national air quality information. This website offers daily Air Quality Index forecasts as well as real-time conditions for over 300 cities across the U.S.

Ozone and PM2.5 Forecasts

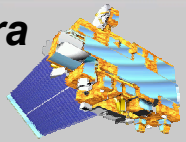


Current Air Quality Conditions

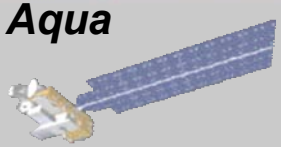


Applying Aerosol Optical Depth for AirNow and Air Quality Forecasting

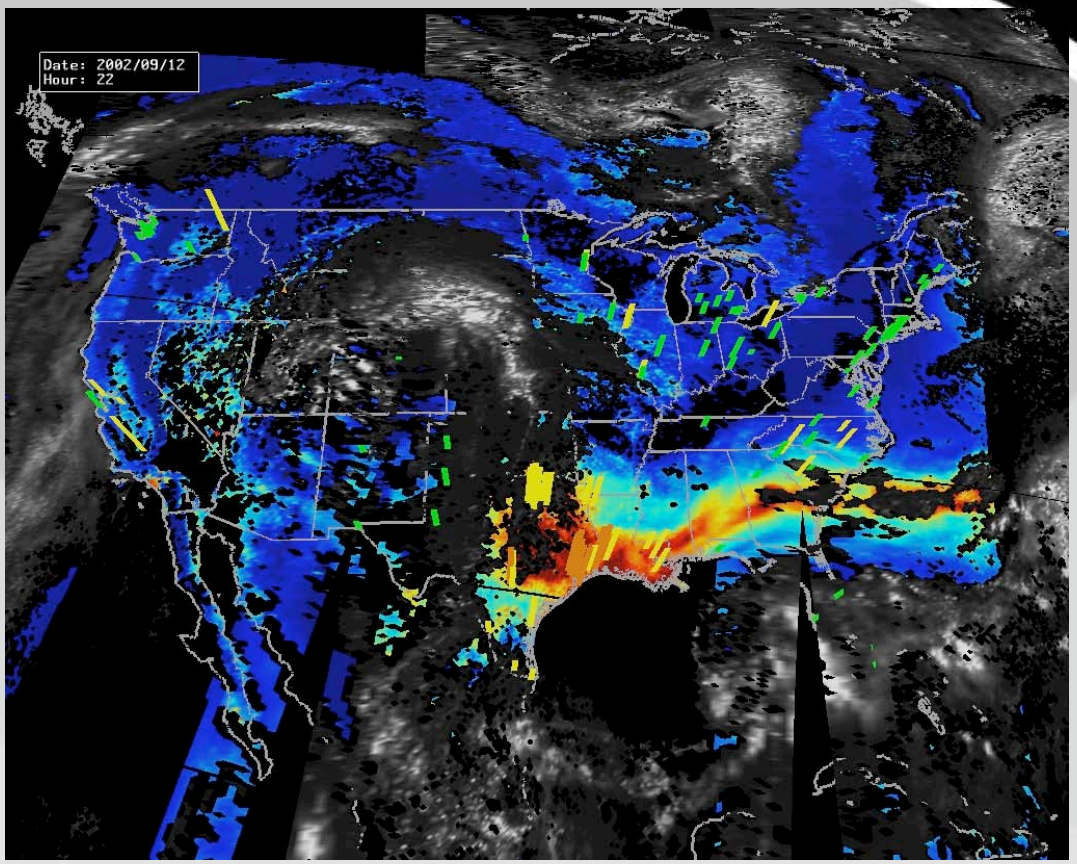
Terra



Aqua



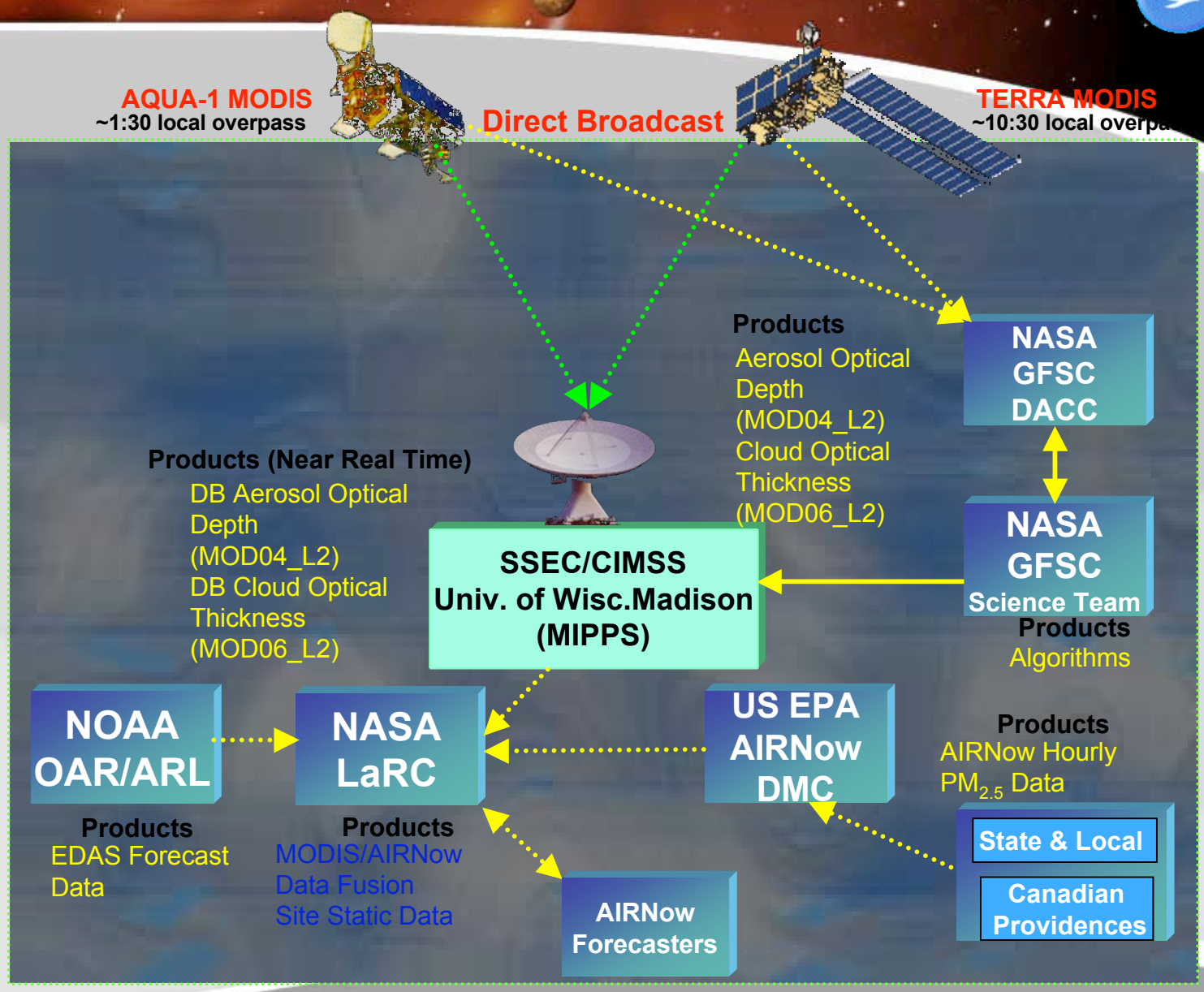
- MODIS Aerosol Optical Depth (AOD) supports EPA/NOAA air quality forecasting & EPA aerosol transport rule making
- Sept. 2003 - successful



MODIS aerosol optical depth & EPA ground measurements of PM2.5.

EPA AIRNow Use of NASA MODIS

Terra & Aqua Satellite Direct Broadcast of MODIS instrument data via commercially available ground station



Air Quality

Clean Air Standards and Air Quality Forecasts

State 2 (c. 2015): ESMF
- **Robust emissions control planning**
- **Routine warnings of pollution events**
- **Multiple-day air quality forecasts**

Socioeconomic Impact

January 2004,
L. Friedl

Simultaneous high-time & space resolved pollutants (O3, CO, NOx, SO2, HCHO, aerosols); local resolution in boundary layer. Nighttime chemistry & transport. Feedbacks betw. aerosols, O3, H20, climate. Chem-radiation coupling in GCMs. Quantify LRT in regional pollution.

Accurate pollution forecasts updated regularly within day. Reduced hospital visits from extreme events. Improved NAAQS planning - fewer non-attainment areas. Insight on mobile emission fluctuations. Advanced, targeted mitigation of impacts from severe episodes.

NPP-NPOESS - ozone trend & aerosols. Feedbacks between O3, H2O, and aerosols. Global trop. winds. Geographic evol. of trop. O3 & aerosols. Lightning NOx emission inventories. Trop. mixing & BL interaction. Urban-scale heat flux. High-res. soundings.

Clear Skies NOx/SO2 Trading Program. Longer lead-time on source & destination of ozone and aerosols. Alerts to re-route airplanes. Alerts to hospitals to expect specific symptoms. Ozone attainment areas. Potential EPA SIP credits for heat island reduction approaches & corresponding state/city policies.

CloudSat & CALIPSO - cloud profiles. Accurate energy & water in MM5. Vertical levels in lower troposphere. Models incorporate radiative forcings. Land-atmos. interactions. Chemistry-transport models. Stratospheric/trop. coupling. Chemistry-climate interactions.

Forecasts of beginning & length of annual "pollution season." Improvements from achievable SIPs - reduced haze, improved visibility in parks, cleaner water, healthier forest ecosystems, reduced lost work/school days. Support US treaty on long-range transport of organic pollutants.

AURA - SO2, NOx, NH3 and aerosol products & IMPROVE network. INTEX-West. NH3 emissions factors; air dispersion models (NOx, CO, PM); MM5 & assimilation of surface moisture, heat capacity, insulation. Nested model developments. RAQMS & DAS for daily 3-D ozone.

Support for goals of Clear Skies initiative. Science-based attribution of source emissions. States quantify voluntary stationary emission reductions within 18 months. Heat island effects in local weather and air quality forecasts. Longer-term AQI forecasts. UV-B notice.

AURA - AURA - AURA. Trop. residuals (O3, NO2, SO2, HCHO); NRT NOx & VOC emission inventories (top-down/bottom-up) for CMAQ & ozone precursors; O3 assimilations in CMAQ; 3-D global trop. chemistry in GEOS-CHEM; aerosol pattern rendering.

Support 2004 NOx SIP call. State justify & EPA corroborates claims for foreign-born pollution waivers. Annual EPA analysis of worst 20 pollution events for trends. Extend PM/O3 forecasting to rural areas - warnings to farmers. Targeted mitigation approaches. Ozone loops in EPA's AQI.

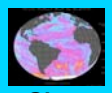
INTEX continental inflow-outflow; ICESat - vertical distribution of dust & clouds; ASTER urban heat flux; Global-to-regional RAQMS - prototype BCs in CMAQ; DAS nested GCM to 0.5° grid. Pollution trajectories & BL deposition of LRT of aerosols. PM network.

States assess emissions control options, development options &emissions strategies to build attainable SIPs. Achievable SIPs improve air quality, public health & economic development opportunities. Urban health alerts for temperature-induced pollution events. EPA guidebook on heat island reduction approaches. States claim waivers for foreign-born pollutants.

MODIS AOD, MOPITT CO, TOMS ozone residuals - correlate to EPA ground measures. Large scale transport of aerosols. GOCART assimilations for B.C.s in models. NRT MODIS-TEOM data fusion.

Policy-Forecasts-Health-Economics. Aerosol transport loops in EPA Air Quality Index (AQI) for regional forecasts. Improved siting for surface monitoring network locations. Support EPA-developed tools for state/locals on regional haze. Evaluate exceptional events for effects on NAAQS violations. EPA PM transport rule making.

State 1 (c.2003)
CMAQ & AIRNow-AQI



2003 2005 2007 2009 2011 2013 2015

* Unfunded

Improved capabilities to air quality managers to assess, plan & implement sound-science, emissions control strategies, policy, & air quality forecasts.

Air Quality

Integrated System Solution

EARTH SYSTEM MODELS

- **Aerosol Transport:** *GOCART*
- **Global-Regional Assimiliations:** *RAQMS*
- **Atmopsheric Chemistry:** *GEOS-CHEM*
- **Emissions:** *SMOKE*
- **Meteorology:** *MM5, ETA*
- **Air Trajectories:** *NOAA-Hysplit4*

Predictions

- **Atmospheric state parameters**
- **Global-to-regional concentrations**
- **Emissions inventories**
- **Regional-Global transport**
- **Trace Gas Sources**
- **Aerosol properties**
- **Ozone profiles & columns**
- **Global-regional boundary conditions**
- **Data fusion techniques**
- **Ground-satellite data comparison techniques**

Data

EARTH OBSERVATORIES

- **Aerosols:** *Terra, Aqua, TOMS, Aura, Aeronet, AIRNow, INTEX, CALIPSO, Glory-APS*
- **Ozone & Precursors:** *TOMS, Aura, SAGE III, AIRNow, INTEX*
- **Trace Gases:** *Terra, Aqua, OCO*
- **Clouds:** *Terra, Aqua, CloudSAT, CALIPSO*
- **Land Use/Cover:** *Terra, Aqua, Landsat*
- **Atmospheric Parameters:** *GOES, POES, GIFTS, NPP, NPOES*

Observations

DECISION SUPPORT TOOLS

CMAQ (**C**ommunity **M**ulit-scale **A**ir **Q**uality modeling system)

- **Assess emissions control strategies**
- **Develop achievable SIPs (State Implementation Plan)**
- **Assess compliance**
- **Waivers to air standards**
- **Quantify voluntary stationary emission reductions**

AIRNow & AQI (**A**ir **Q**uality **I**ndex)

- **Forecast transport of dust/pollutants**
- **Actions to reduce source emissions**
- **$PM_{2.5}$ forecasts**

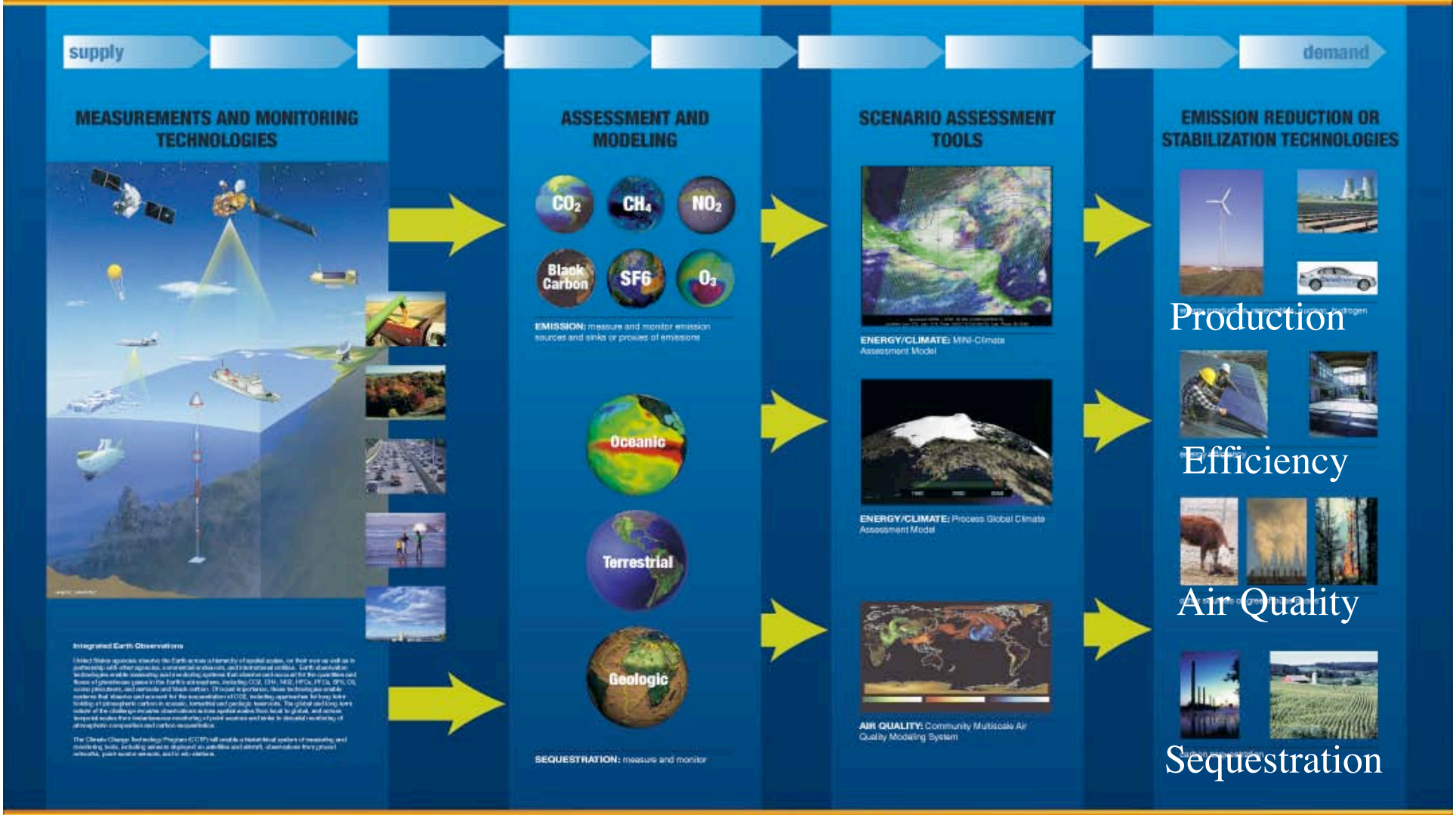
International Treaties

VALUE & BENEFITS

- **Reduce lung-related diseases & premature death**
- **Reduce hospital admissions & use of medicines**
- **Reduce lost workdays and schooldays**
- **Improve visibility and reduce haze for tourism**
- **Improve resiliency of crops; increase yields**
- **Increase confidence in government**
- **Improve crop estimates**
- **Sensitive populations can change activities**

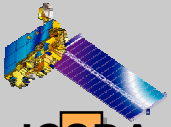
Climate Change Technology Program

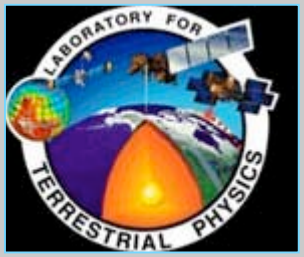
Measurements and Monitoring Framework for the Climate Change Technology Program Strategy

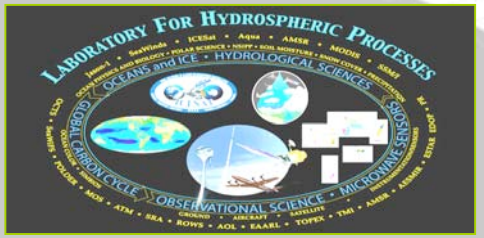


Climate Change Technology Program
www.climatetechnology.gov

Climate Change Science Program: Reducing & Characterizing Uncertainty

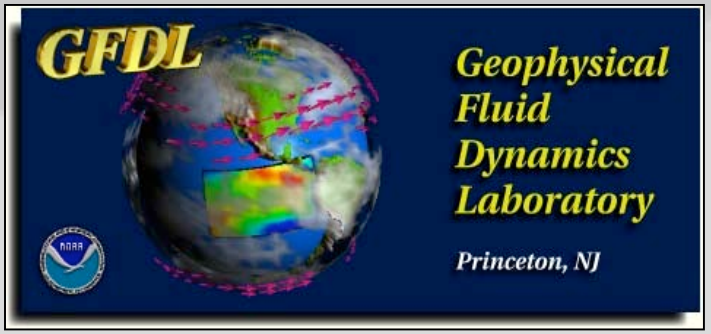




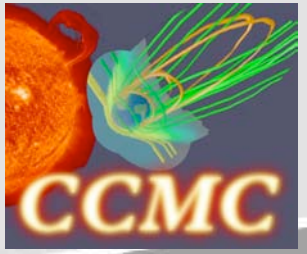


NASA Goddard Space Flight Center
LABORATORY FOR ATMOSPHERES

National Centers for Environmental Prediction



Office of Research and Applications



Observations to Knowledge Products

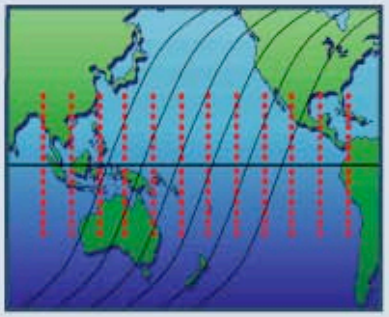
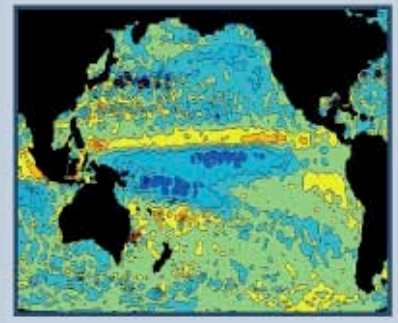
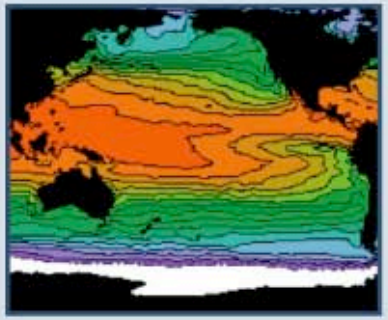
"from photons to electrons to neurons"

Downlink Speed

Petabytes 10^{15}	Terabytes 10^{12}	Gigabytes 10^{9}	Megabytes 10^{6}
Multi-platform, multiparameter, high spatial and temporal resolution, remote & in-situ sensing	Calibration, Transformation To Characterized Geo-physical Parameters	Interaction Between Modeling/Forecasting and Observation Systems	Interactive Dissemination and Predictions
Advanced Sensors	**Data Processing & Analysis**	**Information Synthesis**	**Access to Knowledge**





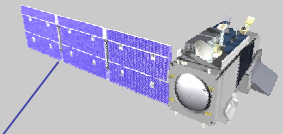

Transition from Research to Operations

Aqua (2002)
AIRS, AMSU & MODIS

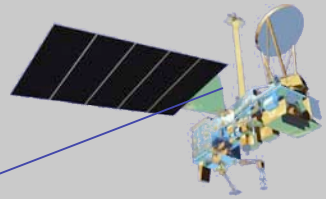
Coriolis (2003)
WindSat

METOP (2005)
IASI/AMSU/MHS & AVHRR

NPP (2006)
CrIS/ATMS
VIIRS
OMPS



NPOESS (2009)
CrIS/ATMS, VIIRS, CMIS,
OMPS & ERBS



Use of Advanced Sounder Data for Improved Weather Forecasting & Numerical Weather Prediction

NOAA Real-Time Data Delivery Timeline Ground Station Scenario

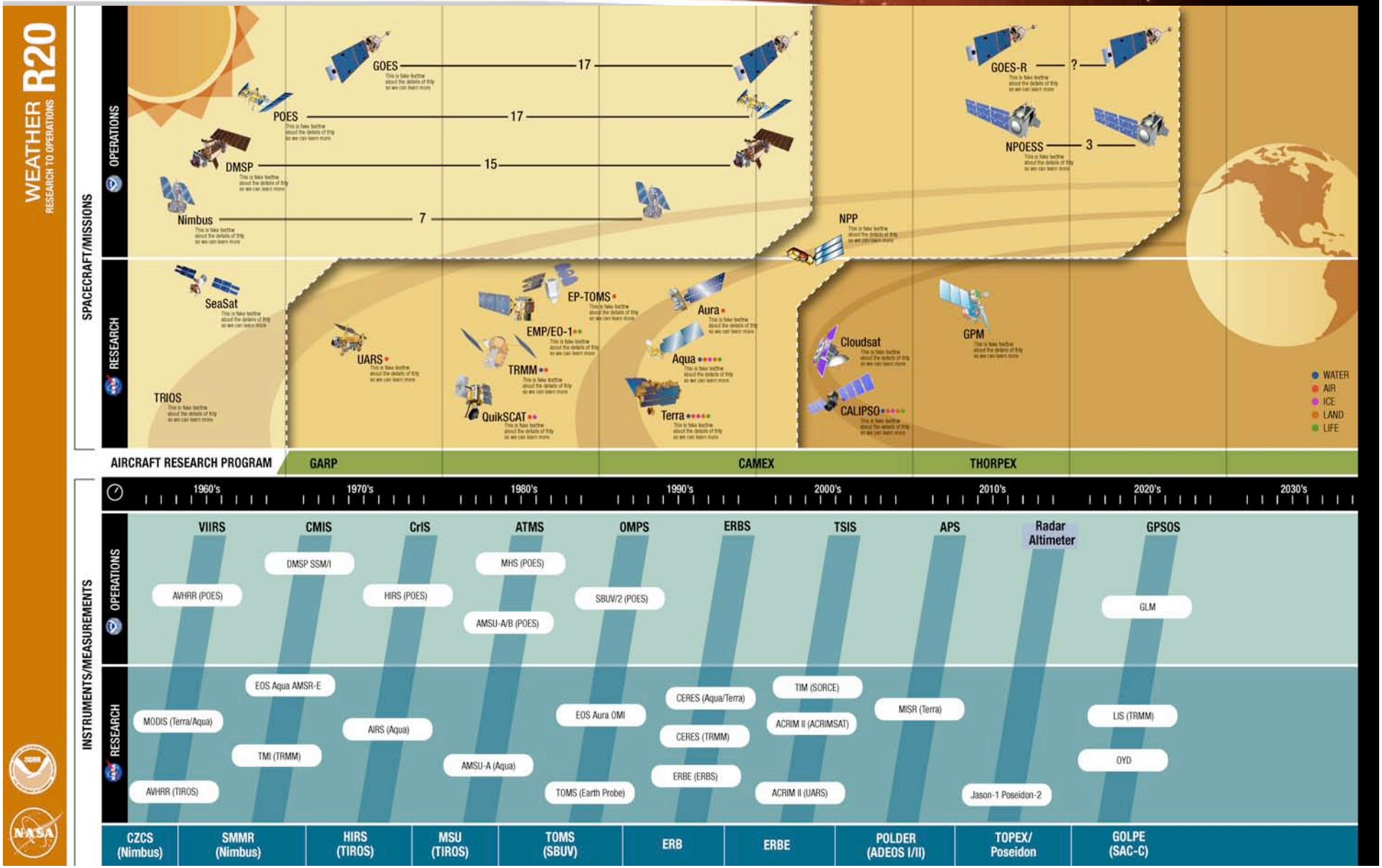
C3S → IDPS → NOAA Real-time User

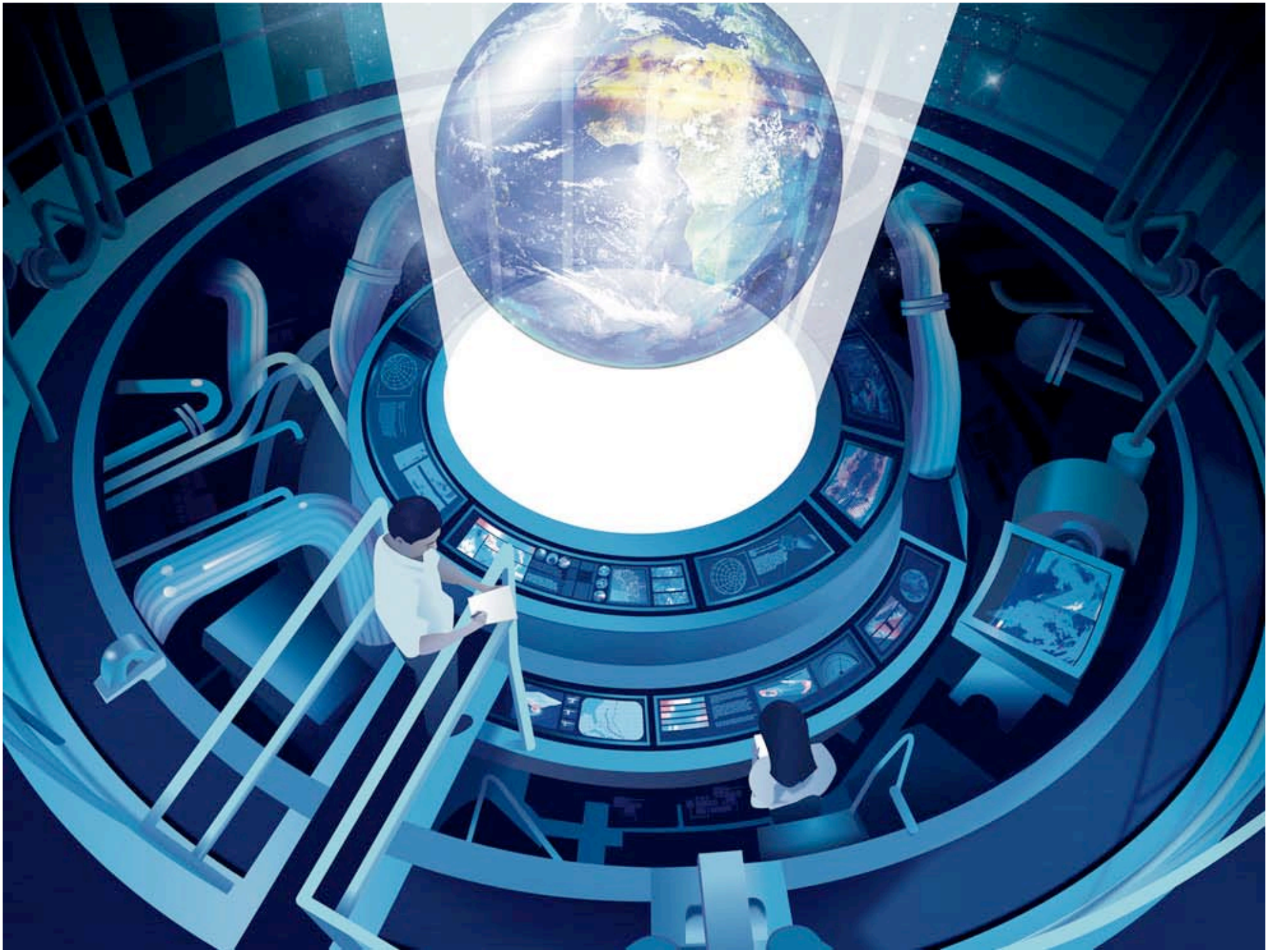
Joint Center for Satellite Data Assimilation

NWS/NCEP
GSFC/DAO
ECMWF
UKMO
FNMOC
Meteo-France
BMRC-Australia
Met Serv Canada

→ NWP Forecasts

Roadmap of R2O for Weather





Additional Information

- Web References
  - GEO http://earthobservations.org
  - IWGEO http://iwgeo.ssc.nasa.gov

Group on Earth Observations

Why GEOSS?

- GEOSS-Global System To Meet Societal Needs
  - **No one organization or country can provide comprehensive capacity**
  - An integrated international system using remote sensing & in situ systems
  - Foundation for sound decision-making: global, regional, & local level
- Social, Economic, & Science Concerns
  - More than half the world's population lives within 60 km of the shoreline, & this could rise to 3/4 by the year 2020
  - More than 90% of natural disaster-related deaths occur in developing countries
  - 25% of Earth's biological productivity & an estimated 80-90% of global commercial fish catch is concentrated in coastal zones
  - Worldwide agricultural benefits of better El Niño forecasts are conservatively estimated at $450-$550M/year
- Basis For Sustainable Development

Group on Earth Observations

Earth Observation Summit I

- Declaration created ad hoc Intergovernmental Group on Earth Observations (GEO) to develop a 10-Year Implementation Plan

- Four Intergovernmental Chairs:
  - Mr. Akio Yuki, Japan
  - Mr. Achilleas Mitsos, European Commission
  - Dr. Rob Adam, South Africa
  - VADM Conrad Lautenbacher, USN (Ret.), United States

Group on Earth Observations

Earth Observation Summit II

- Held in Tokyo, Japan
  - Prime Minister Koizumi gave keynote address
- 43 Ministers & Heads of Delegation present
- 25 International Organizations represented
- Adopted Framework for Global Earth Observation System of Systems (GEOSS)
- Adopted Ministerial Communiqué

Group on Earth Observations

Earth Observation Summit III

- Brussels, Belgium on Feb.16, 2005
- GEO 6
  - Goal to iron out last editorial issues with Implementation Plan
- Agreement on Implementation Plan and Resolution
  - Ministers to receive Reference Document as Basis of Plan
- Set up new GEO Structure and Secretariat
  - WMO offer to host